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# THE AMERICAN NATURALIST

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VOL. XXXV.

June, 1901.

NO. 414.

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## THE COMPOUND AND MIXED NESTS OF AMERICAN ANTS.<sup>1</sup>

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### PART I. OBSERVATIONS ON A NEW GUEST ANT.

OF the many symbiotic relations known to exist between ants and other living organisms, whether animals or plants, few are more interesting than the relations between ants of different species or even genera that live together in the same nests on terms of mutual toleration or intimacy. In this country, nevertheless, studies like those of Forel ('74), Adlerz ('84, '86, '96), and Wasmann ('91) on the compound and mixed nests of European ants have scarcely been undertaken, notwithstanding the fact that our own ant fauna is known to present numerous cases no less remarkable than those which have been so carefully studied abroad. Sufficient evidence of the truth of this remark will be found in the description of a hitherto unknown form of compound nest which is made the basis of the present paper. This is in many respects so unlike any of the recorded compound nests that it seems worth while, if only

<sup>1</sup> *Contributions from the Zoölogical Laboratory of the University of Texas*, No. 14.

for the sake of comparison, to follow it with a consideration of the other forms of mixed and compound nests that are known to occur on our continent. While it thus becomes necessary to review much that is well known to the myrmecologist, I hope at the same time to call the attention of entomologists, who may have wearied of collecting and mounting our comparatively well-known beetles and butterflies, to an extensive subject, which is as interesting to the collector as it is fascinating to the philosophical observer. Ants' nests of the mixed and compound varieties are of sporadic and often very rare occurrence, so that there is great need of many more observations extending over large portions of our country. While reviewing the various forms of nests in the second part of my paper, I shall include a brief consideration of some interesting compound nests that have recently come under my observation in Texas and Mexico.

During the late afternoon of August 1, 1900, while walking over one of the Litchfield Hills near Colebrook, Connecticut, I found a number of nests of the common red-brown *Myrmica* (*M. brevinodis* Emery) under some small stones that were rather deeply imbedded in the moss bordering the exposed glaciated rock of the hilltop. In four of these nests which were rather close together and not very populous I detected among the *Myrmica* workers a few decidedly smaller and more yellowish ants of a different species running about on the up-turned lower surface of the stones. As my stay in Colebrook was at that time limited to a few days, I carefully replaced the stones in the moss after preserving a few of each of the two species. The smaller ants were sent to Professor Emery of Bologna, who pronounced them to be a new species of *Leptothorax* allied to *L. canadensis* Provencher.

Later in the month of August I returned to Colebrook and at once revisited the *Myrmica*-*Leptothorax* nests. Two of them had disappeared, as if in resentment of my former intrusion into their peaceful life on the hilltop. The third nest contained only a few *Leptothorax* workers. The fourth nest was in good condition and was dug up *in toto* and carried home in a canvas bag. For several days I searched diligently, but in vain, on all the hills about Colebrook for more of these double nests,

though single nests of the *Myrmica* were frequently found. My observations were therefore to be confined to only one nest.

The worker of *Myrmica brevinodis*, which I shall not pause to describe, is represented in Fig. 1. The *Leptothorax*, however,

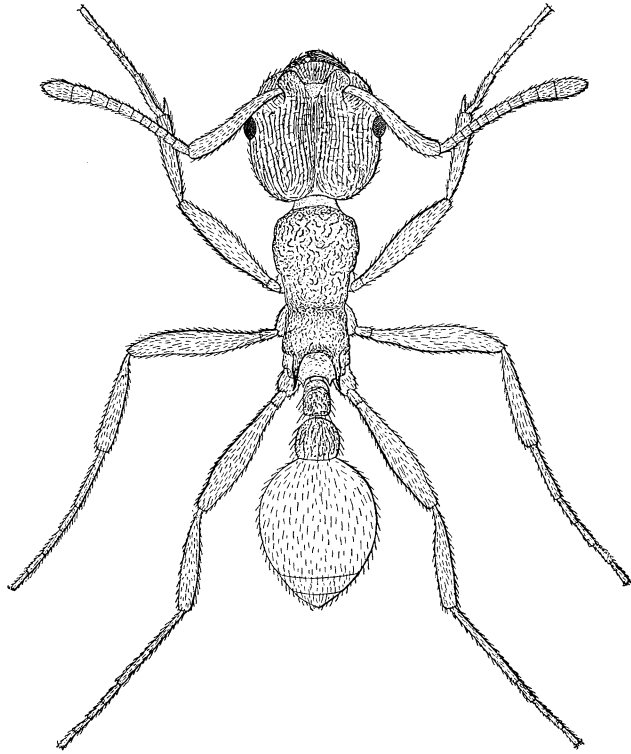


FIG. 1.—*Myrmica brevinodis* Emery. Worker.

is of greater interest in this connection and certainly merits a description before we proceed with any observations on its behavior.

***Leptothorax emersoni* n. sp.<sup>1</sup>**

*Worker* (Fig. 2). Length 2.5–3.5 mm.

Brownish yellow; upper surface of the head except the mandibles, clypeus, and a narrow postclypeal and occipital

<sup>1</sup> I take pleasure in dedicating this species to Mr. Ralph Emerson in memory of the many happy hours which we spent together at Rockwell Hall in Colebrook.

strip, dark brown, as is also a very broad band across the middle of the first abdominal segment and the basal half of each of the succeeding segments. Hairs covering the mandibles, antennæ, legs and body, whitish ; those on the body rather long, coarse

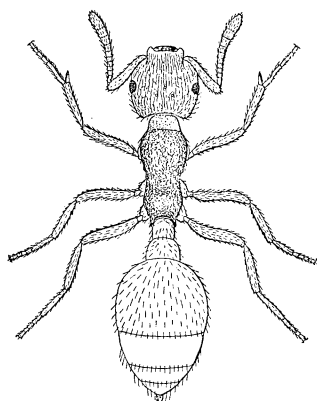


FIG. 2. — *Leptothorax emersoni* n. sp.  
Worker with ocelli.

and truncated, but scarcely clavate at their tips ; those on the limbs tapering and less conspicuous.

Mandibles rather coarsely striated longitudinally and provided with a few setigerous punctures ; cutting edges black. Clypeus moderately convex, smooth in the middle but with a few delicate longitudinal rugæ on either side. Antennæ 11-jointed. Head opaque, above and on the sides coarsely and longitudinally reticulate-rugose, the areolæ enclosed by the rugæ being indistinctly and finely punctate. In the mid-dorsal region of the head the rugæ are close together and their longitudinal course is very distinct, but in the antennal foveæ and on the cheeks and the sides of the head they are farther apart and more reticulate. Some of the workers have two or three minute ocelli which are most easily seen in alcoholic specimens. Thorax faintly but distinctly constricted at the meso-metanotal suture ; opaque, above and on the sides less distinctly reticulate-rugose than the head. Anterior portion of the pronotum, metanotum, and lower pleuræ punctate ; metanotal spines slightly longer than broad at their bases, nearly parallel, terminating in broad, flattened, blunt points. Petiole about twice as long as broad, subopaque, finely punctate, with a pointed dorsal cone, the anterior and posterior surfaces of which are of nearly equal length and inclination, the former being very slightly concave, the latter flat when seen in profile. Postpetiole smooth, subglabrous, hemispherical. Abdomen rather broad, distinctly flattened dorso-ventrally, and very glabrous.

*Female.* Length nearly 4 mm.

Thorax more opaque, more distinctly rugose, and of a darker brown color than in the worker.

*Male* (Fig. 3). Length 2.75–3 mm.

Coloration brownish yellow like that of the worker; head, thoracic dorsum, abdomen, and the middle portions of the femora and tibiae somewhat darker. Wings colorless, with very pale veins and stigmata. Hairs almost completely absent on the head and thorax, short and inconspicuous on the legs, long on the abdomen, but nowhere truncated at their tips.

Mandibles striated, hairy, very small, not distinctly dentate, and far from meeting each other with their blades. Clypeus even in the middle with a few delicate longitudinal rugæ. Head above longitudinally reticulate-rugose; rugæ radiating backwards and laterally from the posterior ocelli as centers. Antennæ 12-jointed; scape scarcely as long as the three first joints of the flagellum taken together; first joint of flagellum very short, the others of uniform thickness but increasing gradually in length towards the tip. Thorax rather smooth, indistinctly punctate; parapsidal and other sutures very distinct; metanotum with two very short rugose projections in the place of the spines. Dorsal projection of the petiole rounded, its posterior slope slightly concave, the anterior convex. Postpetiole hemispherical; abdomen very glabrous, somewhat less flattened than that of the worker.

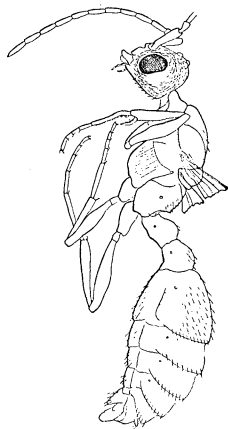


FIG. 3. — *Leptothorax emersoni* n. sp. Male.

*Leptothorax emersoni* is to be assigned to the small group of North-American species comprising *L. muscorum* Nyl. (also recorded from Europe), *L. canadensis* Provencher, with its variety *yankee* Emery, *L. hirticornis* Emery, and *L. provencheri* Emery. The workers of all these forms have 11-jointed antennæ and a distinct meso-metanotal constriction. That the new species is perfectly distinct from all of these is

quite evident from consulting Emery's table of the North-American species of the genus ('95, pp. 317,318).

The above very incomplete account of the female is drawn from memory, as the single specimen escaped from the nest before it could be described.

Some of the workers, especially those which approached the queen in size, possessed minute ocelli. This is shown by the following measurements of the four workers still in my collection :

- No. 1. Length 2.5 mm. No ocelli.
- No. 2. Length 2.75 mm. No ocelli.
- No. 3. Length 3 mm. Two ocelli.
- No. 4. Length 3.5 mm. Three ocelli.

This fact is of some interest, as I shall endeavor to show in the sequel.

On the morning of August 25 the ants were transferred to an extemporized Lubbock nest. This consisted of a board surrounded by water, and a little fine, moist earth placed on the board and covered with a pane of glass. A census of the two species of ants gave the following :

*Myrmica*: 6 deälated<sup>1</sup> queens; 7 males; about 200 workers; a few eggs; 23 larvæ, both young and old (but apparently no queen larvæ); 8 worker and male pupæ. The latter hatched in the course of a few days.

*Leptothorax*: 1 deälated queen; 4 recently hatched males; 14 workers; 2 adult larvæ, which soon became male pupæ.

The earth with its occupants was dumped from the bag on to the pane of the Lubbock nest, and the ants, after the first flurry of excitement, began to seek refuge under the glass. As usual the larvæ and pupæ were at once conveyed to a place of safety. While this operation was going on, it was noticed that some of the *Myrmica* workers carried the *Leptothorax* larvæ, and the *Leptothorax* workers reciprocated by occasionally

<sup>1</sup>I feel compelled to coin this term for use in the sense of the German "ent-flügelt." The term *apterous* cannot be used without confusion, since some ants (*Eciton*, *Dorylus*, *Leptogenys*, *Tomognathus*) have truly apterous queens, whereas the queens of most species of *Formicidæ* have well-developed wings, up to the time of their removal after the nuptial flight.

carrying some of the *Myrmica* larvæ. This action on the part of both species was evidently the result of haste and excitement, as I never saw it repeated subsequently except once, when a *Leptothorax* carried a *Myrmica* larva a short distance and then dropped it.

As soon as the excitement had subsided the *Myrmicas* proceeded to dig galleries in the soft earth between the glass pane and the board, and the *Leptothorax* at once migrated into them. A few hours later the earth that had been dumped on the pane was carefully removed and replaced by a piece of opaque cardboard which was only lifted from the glass when the ants were under observation. A small dish containing a syrup of sugar and water was placed near the nest. This was soon found by two of the *Myrmica* workers, which at once gorged themselves with the liquid and returned into the nest, where they proceeded to dole out the store of food to their hungry sisters. It was then that I was able to make my first observation on the mutual relations of the two species of ants. A *Leptothorax* worker was seen to follow up and to climb on to the thorax of one of the food-distributing *Myrmicas* soon after it had entered the nest. In this position the little ant proceeded to lick the back of the head and clypeus of the *Myrmica* with signs of agitation as indicated by the hastening of the tremulous beat of its antennæ and the throwing of its abdomen and postpetiole into stridulatory oscillation. The *Myrmica* paused as if spellbound by this shampooing and occasionally folded its antennæ as if in sensuous enjoyment. The *Leptothorax*, after licking the *Myrmica*'s pate, moved its head around to the side and began to lick the cheeks, mandibles, and labium of the *Myrmica*. Such ardent osculation was not bestowed in vain, for a minute drop of liquid — evidently some of the recently imbibed sugar-water — appeared on the *Myrmica*'s lower lip and was promptly lapped up by the *Leptothorax*. The latter then dismounted, ran to another *Myrmica*, climbed on to its back and repeated the very same performance. Again it took toll and passed on to still another *Myrmica*. On looking about in the nest I observed that nearly all the *Leptothorax* workers were similarly employed. In one



corner of the nest a number of *Myrmica* workers had formed a circle about a few of their small larvæ which they were cleansing and feeding. A *Leptothorax* soon found its way to this cluster and stepped from the back of one ant to that of another, lavishing a shampoo on each in turn and apparently filling its crop with the liquid contributions thus solicited.

This and numerous very similar observations, which could be made at any time on removing the cover of the nest, prove conclusively that the *Leptothorax* workers demand and obtain their food from the *Myrmica* workers. The method of soliciting food, however, differs from that of any other myrmecoxenous animals known to me. These animals usually request food by tapping the ant with their antennæ (many myrmecophilous beetles), or stroking its face with their fore feet (*Atemeles*), but none of these guests are so unconventional as to mount the backs and scratch the heads of their hosts for the purpose of inducing the latter to regurgitate. Even the slave-holding *Polyergus* and the social parasite *Anergates* demand and receive food after the manner of other ants. The *Leptothorax* workers are so persistent in their peculiar attentions to the *Myrmicas* that I have come to doubt whether the little guest ants ever really feed themselves. Once only was a *Leptothorax* seen to approach the dish of syrup, lap up a very little of it hastily, and then return to the nest. This happened before the ants had definitely settled under the pane of glass. After that only the *Myrmica* workers visited the manger, and the *Leptothorax* usually waylaid them as soon as they had entered the nest. During my first visit to the four natural *Myrmica*-*Leptothorax* nests I found the latter species loitering in the outer galleries just under the stone. I am convinced that they prefer this situation in order to be on hand the very moment a food-laden *Myrmica* enters the nest. The *Leptothorax* workers often walked on the lower surface of the roof-pane, although they had to turn over to mount the passing *Myrmicas*. They must do this also in the natural nests, for the specimens taken August 1 were, as above stated, crawling on the lower surface of the stones.

Although the feeding of the guest ants commonly proceeds

as above described, I have noticed that the *Leptothorax* after mounting a *Myrmica* sometimes turns about and licks the metathorax or even the abdomen of its host, as if, like *Myrmecophila* (see Wheeler, '00), it found the surface covered with some agreeable secretion. It seems, therefore, not improbable that the *Myrmicas* may derive some slight benefit from guests which, like many tonsors, combine the occupation of the barber and bather. It is perhaps unnecessary to add that the *Myrmica* does not always pay for the shampooing it receives. But the *Leptothorax* is not discouraged; it merely dismounts and runs about in the galleries till it falls in with another *Myrmica*.

The *Leptothorax* workers were never seen to approach the male *Myrmicas*, and only once did I see one shampooing one of the queens. So conspicuous was this neglect of the two fertile sexes of their hosts and their predilection for the workers, that I was convinced that they habitually ignore the queens and males, because these insects, like themselves, depend on the *Myrmica* workers for their sustenance and are probably on that account not in the habit of regurgitating.

On the evening of the day on which the ants moved into the Lubbock nest and during a portion of the following day, August 26, the queen *Leptothorax* wandered about outside the nest as if seeking a more favorable retreat. By 4 P.M., however, she had entered the nest and, with eight of her workers gathered about her and her two mature larvæ, was found occupying a small earthen chamber under the very middle of the roof-pane. This chamber, which had evidently been dug by the *Leptothorax*, was surrounded on all sides by the large galleries of the *Myrmicas*. Seen from above, the *Leptothorax* nest had the appearance of Fig. 4 *a*. The queen, workers, and larvæ, nearly filled the small cavity, *a*, which communicated with a wide *Myrmica* gallery, *c*, by means of a passage, *o*, too small to admit a *Myrmica*. Through this narrow passage a few *Leptothorax* workers entered or passed out from time to time, but several always remained in the nest with their queen. Usually from one to six workers were to be seen soliciting food among the *Myrmicas*.

Three of the six *Myrmica* queens, together with the *Leptothorax* males, were preserved in alcohol, as the nest was somewhat over-crowded with the former species and the latter were continually escaping. The three remaining *Myrmica* queens stationed themselves some distance apart in the galleries, and each was soon surrounded by a coterie of devoted workers. The larvæ and pupæ were being cared for in two or three different portions of the nest.

The *Leptothorax* in their small central nest passed their time in fondling and feeding one another or in lying motionless as if asleep, covering the two larvæ which had been placed in the bottom of the nest. The queen was assiduously fed by the workers and was never seen to leave the nest after once taking possession of it. On several occasions she was observed to throw one of the workers down on its back and to hug and kiss it in the most animated manner. It was not easy to decide whether this behavior signified maternal affection, the presence of some form of the play instinct, or the more prosaic feeling of hunger. I incline to the last possibility, although the action certainly resembled the affectionate struggles of a cat with her kitten.

During the remainder of this day (August 26) the *Leptothorax* nest remained in the condition represented in Fig. 4. By 8 o'clock the following morning, however, the bottom of the nest had been dug somewhat deeper, its narrow entrance had been closed up and a new one, equally tenuous, had been opened in a different position (Fig. 5 *r*). The two larvæ had become male pupæ. By noon the queen had laid three elliptical white eggs of rather large size. At 1 P.M. the *Myrmica* workers discovered the hiding place of their little companions, and two of them in single file shouldered their way through the narrow passage, *r*, enlarging it as they proceeded. As soon as the head of the first *Myrmica* appeared in the chamber, the *Leptothorax*, which had been attending to their morning toilet and to that of their larvæ and to the careful arrangement of their eggs, turned to meet the intruders. For an instant I fully expected to see a fierce battle, but I had misjudged the *Leptothorax* character. To my surprise the *Myrmica* and

her companion on entering the chamber were received with a profusion of shampooing. The large *Myrmicas*, though sadly crowding the occupants of the little chamber, let themselves

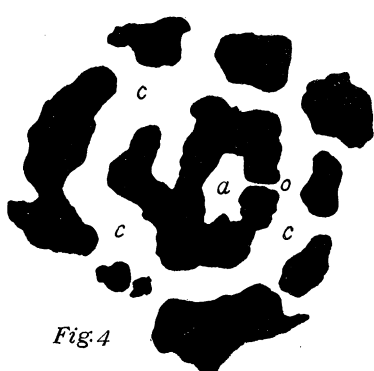


Fig. 4

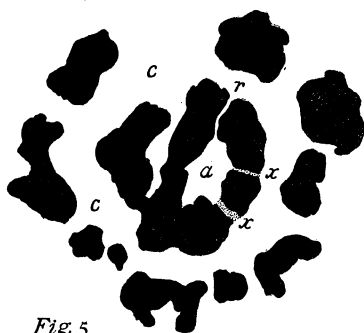


Fig. 5



Fig. 6

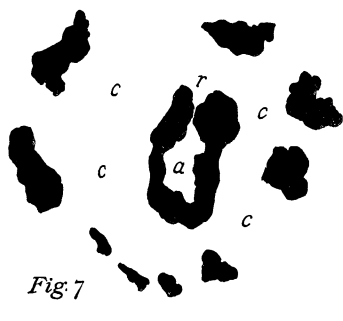


Fig. 7



Fig. 8

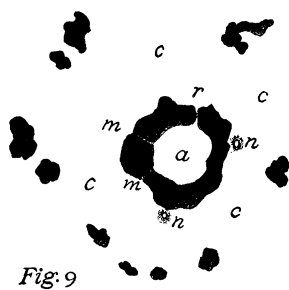


Fig. 9

FIGS. 4-9. — Nest of *Leptothorax emersoni* n. sp., within the nest of *Myrmica scabrinodis* Nyl.

down comfortably and appeared to experience all the sensuous satisfaction of a couple of jaded roués who have dropped into a Turkish bath for the night. The naturalist of a past generation would probably have interpreted the behavior of *Leptothorax*

under these circumstances as a politic act of hospitality on the part of a defenseless but intelligent creature. To-day there would be little hesitation in interpreting it as merely a machine-like reflex called into activity by its customary stimulus, the presence of the *Myrmicas*. That the truth lies somewhere between these two conceptions, though possibly nearer that of reflex than of intelligent action, was apparent from the subsequent behavior of the *Leptothorax*. These ants undoubtedly had some dim desire to remove the *Myrmicas* from their nest, for from time to time a *Leptothorax* was seen to pull with her mandibles at the fore leg or antenna of one of the intruders, as if to remind her that there are limits to polite hospitality. This action was never performed by the *Leptothorax* while foraging in the *Myrmica* galleries, but it was regularly performed whenever, as on this and several subsequent occasions, any *Myrmica* broke into the central chamber. The direction of the tugging was not very definite or constant. Often when a *Myrmica* thrust its head through the wall, the tugging was indeed towards the interior of the chamber, as if to draw the intruder in. But as the small ant was not able to move the large *Myrmica*, and as it could not under the circumstances tug in any other direction, the action could hardly be regarded as anything more than a gentle means of persuading the *Myrmica* to leave. This tugging was the only act even approaching hostility witnessed between the two species. The *Myrmicas* never showed the slightest irritation towards the *Leptothorax*, never seized them in their mandibles, nor even menaced them. They seemed rather to look upon the little creatures with gentle benevolence, much as human adults regard little children. They never passed their little guests without the antennal greeting, and the *Leptothorax* shampooed their hosts with comical zeal.

The two *Myrmica* workers whose intrusion into the *Leptothorax* chamber led to the above observations finally departed, only to give a second party of *Myrmicas* an opportunity to make a large breach in the wall at *xx*. These entered the chamber at 1.20 P.M. and were received in the same gracious manner as the first party, and in turn departed after being as

politely requested to leave. The *Leptothorax* then at once set to work to repair their dilapidated wall. At 1.30 a worker went out into the adjoining gallery, picked up a pellet of earth and placed it in the breach. Again and again she returned and gathered earth, often going to a distance of one or two inches from the chamber for suitable pellets. Another worker soon began to assist in repairing the breach from the inside, taking the pellets for this purpose from the inner wall of the chamber. Then the first worker walked around the nest, entered it through the passageway at *r* and began to clean herself, while a third worker went out through the breach and continued the work on the outside till the wall was completed. This was accomplished by 3 P.M.

At 4 P.M. a little water was poured under a corner of the glass where the *Myrmicas* had congregated in greatest numbers. This additional moisture induced them to move *mit Kind und Kegel* to the middle of the nest. Here they soon began to break through the walls of the *Leptothorax* cell in two places (Fig. 6 *s s*). Two *Myrmicas* again settled down in the cell and underwent the usual shampooing. As soon as they had departed the little ants again set about repairing the walls as before. Sometimes three or four of them worked at the same breach. During the progress of the work they frequently went from two to three inches into the *Myrmica* galleries in search of the requisite earth. At the same time a few workers toiled from the inside of the cell, and these were soon joined by the queen, working as busily as any of her progeny.<sup>1</sup> Occasionally a worker, after building for some time on the outside, would slip through the breach, turn around and build from the inside. Twice *Myrmicas* rushed up to the spot *s* (on the right side in Fig. 6) and commenced tearing down the wall. They easily took out pieces of earth eight or ten times as large as those which the little *Leptothorax* workers were putting in with so much care and difficulty. But the infraction of the *Myrmicas* did not escape the attention of the *Leptothorax*. They

<sup>1</sup> It is interesting to note in this connection that Forel ('74, pp. 339-341) long ago observed that the queens of the European species of *Leptothorax* (*L. acervorum* and *tubero-affinis*) do not shirk their share of the menial labors of the nest.

interrupted their repairs to shampoo and kiss the interlopers and again they tugged them by a leg or an antenna, sometimes in one direction, sometimes in another. And again I was forced to conclude that the *Leptothorax* workers wished to dissuade their big hosts from trespassing on their property. At any rate, the *Myrmicas* changed their plans and retreated to another part of the nest, just as the other parties had done on former occasions. The *Leptothorax* then continued their repairs. By 6 P.M. the walls had been rebuilt and the cell had the appearance of Fig. 7. The original entrance, *r*, had been much narrowed so as to exclude all but the slender-bodied inhabitants of the chamber.

At 7 o'clock on the following morning (August 28) the *Leptothorax* nest was found in *statu quo*, except that the queen had laid three more eggs during the night. By noon, however, the *Myrmicas* had again broken into the cell, so that at 4.30 P.M. the wall was torn down in several places. Nevertheless, the ever alert guest ants had piled up the earth so that the *Myrmicas* could scarcely squeeze between it and the glass roof-pane. The inroads of the *Myrmicas* had been so extensive, however, that even as late as 7 P.M. the nest presented the appearance of Fig. 8.

By 7 A.M. on the following day (August 29) the nest had been almost entirely rebuilt, as shown in Fig. 9. The *Leptothorax* must have labored during a large portion of the night. They had remodeled the nest, giving it a circular form, whilst apparently retaining the old opening at *r*. Besides this opening they had two others at *n n*, which were underground passages. The ants could be seen diving into these and anon reappearing within the circular chamber, the bottom of which had been sunk still deeper in the soil. The neat little nest now contained ten eggs. From day to day the *Myrmicas* had been widening their galleries, as is readily seen by comparison of Figs. 4 to 9, so that only small pillars of earth remained to support the roof-pane around the *Leptothorax* cell.

On succeeding days essentially the same conditions as those above described were repeated with slight differences in detail. For the sake of completing the history of the double nest, the

observations extending from August 30 to September 4 are condensed in the following notes :

*August 30.* The round cell, which remained undisturbed all day yesterday, was still intact at 8 o'clock this morning. By noon, however, the *Myrmicas* had torn down its wall in several places, and three of them were found in the cell, submitting to a vigorous shampoo. By 8 o'clock in the evening the circular nest had been rebuilt. The opening at *r* had been closed and a new one opened at *m* (upper left-hand corner of cell in Fig. 9).

*August 31.* Almost an exact repetition of yesterday's performance.

*September 1.* This morning the reconstructed *Leptothorax* cell is smaller. Its upper entrance, *m*, and the two subterranean entrances, *nn*, have not been changed. The ants have sunk the pupæ and eggs to a greater depth in the earthen floor of the nest, so that they are almost in contact with the board. The nest was not molested by the *Myrmicas* during the day.

*September 2.* The cell this morning has further decreased in size but is still intact. Its cavity is not more than 7 mm. in diameter, so that the *Leptothorax* family is much crowded. The two subterranean entrances at *nn* are still in use but the upper entrance has been shifted to *m* (lower left-hand corner of cell in Fig. 9). The *Myrmicas* still leave the cell unmolested.

*September 3.* To-day, too, the *Leptothorax* were left in peaceful possession of their cell. Many of them went out into the galleries from time to time to shampoo the *Myrmicas* and solicit food, which they then distributed to their queen and to the few workers remaining at home. During the day the upper entrance at *m* was closed so that the wall of the nest was everywhere in close contact with the roof-pane. The ants still entered and left the chamber through the two underground entrances at *nn*.

*September 4.* At 8 A.M. the *Leptothorax* nest was unchanged, but by noon its circular walls had grown perceptibly thinner, as the *Myrmica* workers had again taken to removing the earth from the outer surfaces. The nest was now shaped like a volcano with sloping sides and the guest ants inhabiting the crater. By 5 P.M. the *Myrmicas* had made two breaches in the walls. The nest remained in this condition throughout the evening.



The rhythmical assaults of the *Myrmicas* on the *Leptothorax* retreat in the afternoon, on several of the days during which the ants were observed, is, I believe, to be explained as the result of rising temperature. In the Litchfield Hills the nights and mornings of late August and early September are rather cool, while the noon hours may be very warm. The Lubbock nest happened to be placed at a window in a room with southwestern exposure, so that the diurnal variation in temperature must have been keenly perceived by the ants. In the warm afternoons the activities of the *Myrmicas* increased; they ran about more rapidly, became more enterprising, and indulged their excavating instincts to a greater extent. Then in the course of this employment they often broke into the *Leptothorax* retreat.

The fact that the *Leptothorax* changed their entrances from time to time, and, as shown by the figures, kept perfecting the form of their cell, thereby making it easier to guard and rebuild and more difficult for the *Myrmicas* to demolish, is evidence of the remarkable psychic plasticity of these ants. Similar behavior on the part of ants that have been repeatedly disturbed by other species are recorded by different observers. Forel ('94, p. 8) brought a large formicary of *Myrmicocystus altisquamis* from Algiers and gave it an opportunity to establish itself in a garden near Zürich. The African ants were much annoyed by the incursions of *Lasius niger* and *Tetramorium cæspitum*, and although they at first adhered to their Algerian custom of maintaining a large open entrance to their nest, they learned during the course of the summer to narrow the opening gradually. Finally they plugged it up completely with grains of earth and made only a small temporary orifice whenever they strolled out on sunny days. Wasmann ('97, pp. 69, 70) mentions a nest of *Formica sanguinea* that resorted to a similar method of protecting itself from the repeated attacks of a neighboring colony of *F. pratensis*. All these observations go to show that Bethe's conception ('98; '00) of ants as mere "reflex machines" cannot be entertained.

From the persistent and strenuous efforts of the *Leptothorax* to intrench themselves, and from the shape and character of

their chamber and its entrances, we are justified in concluding that these little guest ants must be in the habit of constructing similar lodgings for themselves in the midst of the natural nests of the *Myrmica*. In their natural environment the *Leptothorax* would not be cramped for space as they were in the artificial nest, and they would probably dig their cell where they would not be so frequently disturbed by their inquisitive hosts.

While making the observations above recorded I was much impressed with the poverty-stricken appearance of the *Myrmica* colony. Although it originally contained no less than six fertile queens, the number of workers, larvæ, pupæ, and eggs was disproportionately small. Furthermore, many of the workers were of rather diminutive size, and a few of them had crippled abdomens. I began to suspect that the *Leptothorax* might be appropriating the liquid food regurgitated by the *Myrmica* workers on the mouths of their larvæ. With this in mind I closely watched the larvæ and the inquiline ants. Once I saw a *Leptothorax* lick the mouths of two young larvæ that were lying side by side, and on another occasion a *Leptothorax* licked the body of one of the larvæ. But finally, on September 3, I made an observation which convinced me that the regurgitated food is not stolen from the mouths of the *Myrmica* larvæ. On the morning of that day four *Myrmica* workers were found tugging at the head of a large larva. Under the lens I could see that a mass of regurgitated syrup had hardened over the face of the larva like a mask, and that the four workers were trying to remove it. At last one of them succeeded in pulling it off, and while she was moving away with it the mass stuck to the roof-pane for a moment, and I could see that it was quite hard and glutinous and must have remained on the face of the larva for some time. As the *Leptothorax* were continually roving about the galleries in search of food, they could hardly have failed to appropriate so rich a morsel if they were in the habit of obtaining their food in this manner. If any conclusion can be drawn from the single nest to which my observations have been confined, it would seem to be that the poverty-stricken condition of the *Myrmicas*, notwithstanding the number of fertile queens, must be brought

about more indirectly by the *Leptothorax*, *viz.*, by their continually pestering the *Myrmicas* for food and thus diverting to their own use much of the sustenance that would, under other conditions, benefit the *Myrmicas* themselves and their progeny.

If I have correctly estimated the influences which may tend to diminish the fecundity and prosperity of the *Myrmicas* we have in this double nest another striking demonstration of the complete absence in ants of any faculty of reason. For, if the *Myrmicas* possessed a glimmer of this faculty, they could easily annihilate the gluttonous little nest mates that are forever roaming about their galleries like so many animated stomach pumps.

As I was obliged to leave Colebrook I took advantage of the cold morning of September 5, when the ants were inactive, to transfer them all to a Cohansy jar containing some earth. From this date till October 1 I was traveling about and was therefore compelled to suspend observations on the compound nest. On returning to Austin, Texas, October 1, the ants were again transferred to a Lubbock nest, but to my dismay I found only the queen and a single worker of the *Leptothorax* remaining. The eggs, the two male pupæ, and the other workers of this ant, together with nearly all the larvæ and pupæ of the *Myrmica*, had disappeared. The *Leptothorax* queen was very uneasy and wandered about outside the *Myrmica* nest. On the following day she disappeared. She had probably contrived to cross the moat on the bodies of some drowned *Myrmicas*.

The single worker remained in the nest and for several days ran about shampooing the *Myrmicas* and soliciting food. On October 7 she, too, escaped from the nest and was found struggling in the moat. She was rescued from drowning and soon recovered sufficiently to crawl into the nest, though she showed no desire to mingle with the *Myrmicas*. Finally she lay motionless in a deserted gallery, where she was found dead the next morning. Thus ended the last of these fascinating little ants.

(*To be continued.*)